



Australian Government

MEM23121A Analyse loads on frames and mechanisms

Release: 1

MEM23121A Analyse loads on frames and mechanisms

Modification History

Release 1. Replaces MEM23091A, but not equivalent.

Unit Descriptor

This unit of competency covers the analysis of loads on mechanisms, frames and structural support elements, such as linkages, rods, shafts and beam elements within machines and mechanisms. It includes safe working practices, work health and safety (WHS) compliance requirements, function and features of frames and mechanisms, load and deflection analysis for static and dynamic elements, and traditional and software-based techniques.

Application of the Unit

This unit applies to the analysis of loads on mechanisms, beams, frames and support elements either individually or with the assistance of a professional engineer for more complex calculations of loads and stresses. It is suitable for people working as mechanical detailers or designers and draftspersons, and those pursuing careers and qualifications in mechanical engineering or related disciplines.

Licensing/Regulatory Information

Not applicable.

Pre-Requisites

MEM23004A	Apply technical mathematics
MEM23007A	Apply calculus to engineering tasks
MEM23109A	Apply engineering mechanics principles

Employability Skills Information

This unit contains employability skills.

Elements and Performance Criteria Pre-Content

Elements describe the essential outcomes of a unit of competency.

Performance criteria describe the performance needed to demonstrate achievement of the element.

Elements and Performance Criteria

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| 1 | Establish scope of frame and mechanism analysis | 1.1 | Determine compliance requirements of relevant WHS and regulatory requirements, codes of practice, standards and risk assessment and for design and use of machines and equipment |
| | | 1.2 | Identify features, functions, operating conditions and performance requirements of frames, beams and mechanisms |
| | | 1.3 | Investigate sustainability implications of frames and mechanisms |
| | | 1.4 | Review design loads, working stresses, allowable deformations and factor of safety for elements |
| | | 1.5 | Review element arrangements, assembly and fastening methods |
| | | 1.6 | Identify any complex load calculations to be done with or obtained from a professional engineer |
| | | 1.7 | Establish availability of other technical and professional assistance |
| | | 1.8 | Identify and evaluate appropriate analysis techniques, software and software validation techniques |
| | | 1.9 | Identify stakeholders to be consulted on selection tasks |

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| 2 | Analyse loads and performance of frames and mechanisms | 2.1 | Estimate static and dynamic operating conditions and determine design or selection parameters |
| | | 2.2 | Optimise frame, beam and mechanism elements for strength, deflection, arrangement and fastening |
| | | 2.3 | Review analysis with stakeholders and make any required adjustments |
| | | 2.4 | Confirm compliance of frames and mechanisms with WHS and regulatory requirements, standards and codes of practice |
| 3 | Report results | 3.1 | Record results of scoping, principles and techniques identification and analysis |
| | | 3.2 | Provide documentation, such as calculations, specifications diagrams and drawings |

Required Skills and Knowledge

This section describes the skills and knowledge required for this unit.

Required skills

Required skills include:

- applying safe working practices and procedures when working with frames, mechanisms and equipment
- evaluating frames, beams and mechanisms for WHS, regulations and risk management requirements
- investigating sustainability implications of frames and mechanisms
- reviewing design features, functions and performance requirements of frames, beams and mechanisms, including:
 - dynamics
 - design loads
 - working stresses
 - allowable deformations and factor of safety element arrangements
 - assembly and fastening methods
- selecting appropriate analysis techniques, software and software validation techniques
- identifying relevant analysis support, such as graphs, tables, nomograms or computer-aided solutions and validation techniques
- analysing static and dynamic operating conditions and determining design or selection parameters
- optimising frame, beam and mechanism elements for strength, deflection, arrangement and fastening
- communicating with stakeholders
- reporting and documenting results of analysis, including calculations, specifications, diagrams and drawings

Required knowledge

Required knowledge includes:

- WHS and regulatory requirements, codes of practice, and directives and standards, including those related to risk management
- current options and trends in performance analysis software, including underpinning program and software validation techniques
- types and functions of frames and mechanisms
- mechanisms for converting linear to rotary motion and rotary to linear motion
- lifting machines

- design loads, working stresses, allowable deflections and factor of safety for machine elements
- conditions for equilibrium
- non-coplanar and force systems
- equilibrium of non-coplanar and non-concurrent force systems
- reactions at beam supports (e.g. simply supported, overhung and cantilever beam with vertical and oblique concentrated, uniform and variable distributed loads and couples)
- shear force and bending moments
- shear force and bending moment diagrams
- vertical and oblique concentrated and uniform and variable distributed loads
- types and locations of stresses, including:
 - combined stresses
 - thermal stress due to restrained expansion
 - stress concentration and fatigue due to alternating stresses
- centre of gravity
- centre of percussion
- methods of analysis of frames and trusses
- deflection of beams
- statically indeterminate beams
- buckling of compressed members
- loads and stresses on bolted and welded connections
- static versus dynamic forces, balanced and unbalanced
- dynamics and laws of rotational motion
- dynamic analysis of mechanisms
- linked bodies in motion, including types, impulse, momentum and work energy methods
- work, energy and power for balanced and unbalanced force systems

Evidence Guide

The evidence guide provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge, range statement and the Assessment Guidelines for the Training Package.

Overview of assessment	A person who demonstrates competency in this unit must be able to analyse loads on a variety of frames and mechanisms to confirm performance and safety compliance.
Critical aspects for assessment and evidence required to demonstrate competency in this unit	Assessors must be satisfied that the candidate can competently and consistently: • identify and review features, functions and performance requirement of frames, beams and mechanisms • identify complex calculations requiring professional engineering assistance • establish dynamics, design loads, working stresses, allowable deformations and factor of safety element arrangements for calculations to be done • evaluate assembly and fastening methods, analysis techniques, software and software validation techniques • analyse static and dynamic operating conditions and determine design or selection parameters • optimise frame, beam and mechanism elements for strength, deflection, arrangement and fastening • communicate and negotiate with stakeholders, professionals and technicians and make adjustments accordingly • evaluate frames, beams and mechanisms for WHS and regulatory requirements, and risk management compliance • report and document results.
Context of and specific resources for assessment	• This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, then a simulated working environment must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. • Where applicable, reasonable adjustment must be made to work environments and training situations to accommodate ethnicity, age, gender, demographics

	and disability. Access must be provided to appropriate learning and/or assessment support when required. Where applicable, physical resources should include equipment modified for people with disabilities.
Method of assessment	- Assessment must satisfy the endorsed Assessment Guidelines of the MEM05 Metal and Engineering Training Package. - Assessment methods must confirm consistency and accuracy of performance (over time and in a range of workplace relevant contexts) together with application of underpinning knowledge. - Assessment methods must be by direct observation of tasks and include questioning on underpinning knowledge to ensure correct interpretation and application. - Assessment may be applied under project-related conditions (real or simulated) and require evidence of process. - Assessment must confirm a reasonable inference that competency is not only able to be satisfied under the particular circumstance, but is able to be transferred to other circumstances. - Assessment may be in conjunction with assessment of other units of competency where required.
Guidance information for assessment	Assessment processes and techniques must be culturally appropriate and appropriate to the language and literacy capacity of the candidate and the work being performed.

Range Statement

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording, if used in the performance criteria, is detailed below. Essential operating conditions that may be present with training and assessment (depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts) may also be included.

Structural support and machine elements	Typically these are beam, strut and tie elements of machines and machine supports subject to bending, tension, compression and shear stresses, and may include: - shafts, levers, cams and linkages - frames, staunchions and beams
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	- mechanisms for converting linear to rotary motion and rotary to linear motion - mechanisms with up to five linkages - lifting machines
Machine mechanisms	Machine mechanisms refers to a device to produce a constrained motion while producing a required output. A mechanism is an assembly of elements or links which may be called 'kinematic pairs', which remain in contact throughout their motions. One link, typically the base element, is fixed. Kinematic pairs may be described as turning, sliding, rolling or skidding pairs
WHS, regulatory requirements and enterprise procedures	WHS, regulatory requirements and enterprise procedures may include: - WHS Acts and regulations - relevant standards - codes of practice - risk assessments - registration requirements - safe work practices - state and territory regulatory requirements
Standards and codes	Standards and codes refer to all relevant Australian and International standards and codes applicable to a particular frame and mechanism
Load calculations to be done with, or obtained from, a professional engineer	The unit requires the ability to identify calculations that should be obtained from or calculated with the assistance of a professional engineer. These may include: - regulatory or organisational requirement for professional engineer involvement - static and dynamic complex analysis of loads, including resulting stresses and deformations - choice of graphical and mathematical methods and software options
Appropriate licensed technical and professional assistance	Appropriate licensed technical and professional assistance may include: - technical support and advice relating to elements which have intrinsic dangers, such as: - high pressure - energised fluid vessels - high temperatures and heat energy capacity - wiring with high current control voltages above extra low

	voltage - professional support for technologies, such as: - specialist electric motor drives and controllers - specialist materials, plastics, metal alloys and nano materials - special processes, foundry, alloy welding, heat treatment, sealing and fastening
Sustainability	Sustainability is used to mean the entire sustainable performance of the organisation/plant including: - meeting all regulatory requirements - conforming to all industry covenants, protocols and best practice guides - minimising ecological and environmental footprint of process, plant and product - maximising economic benefit of process plant and product to the organisation and the community - minimising the negative WHS impact on employees, community and customer
Appropriate computer-aided solutions and validation techniques	Appropriate computer-aided solutions may include: - software employed for performance analysis/modelling. Underpinning program techniques and algorithms should be understood, such as the use of finite element analysis (FEA) and numerical methods within object oriented modelling techniques Validation techniques include: - comparison of traditional solutions for simple design problems with software solutions to the same design problems - review of previously implemented design challenges which were completed using the software

Unit Sector(s)

Competency field

Unit sector Engineering science

Custom Content Section

Not applicable.